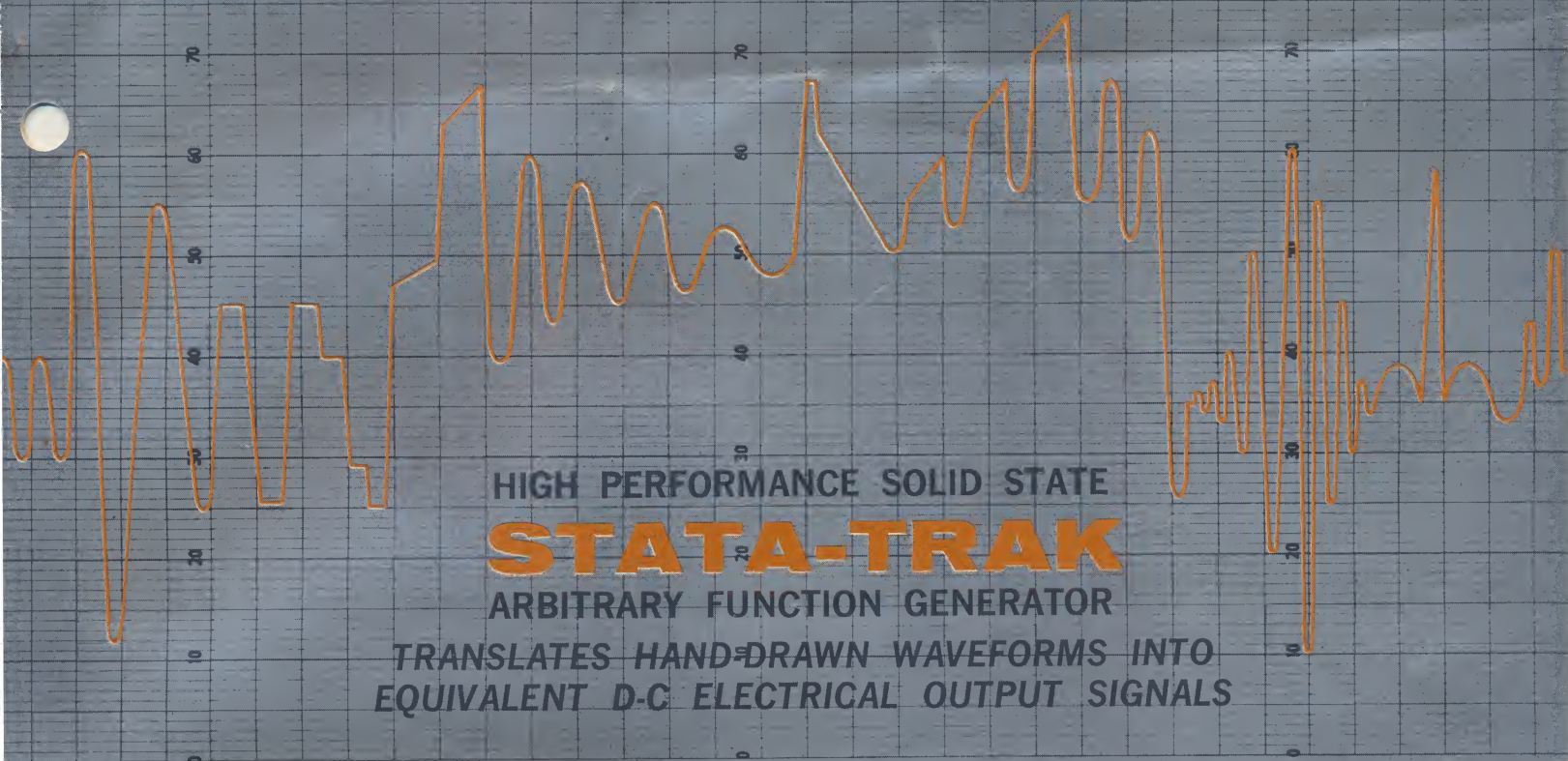


NOW!

CREATING SIMPLE OR COMPLEX ARBITRARY WAVEFORM PROGRAMS IS AS EASY AS DRAWING A LINE...



HIGH PERFORMANCE SOLID STATE

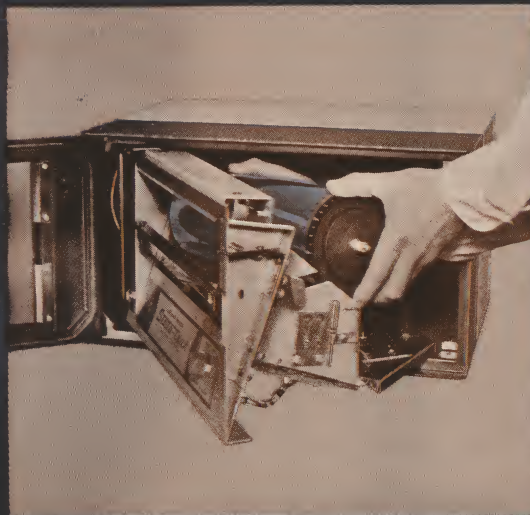
STATA-TRAK

ARBITRARY FUNCTION GENERATOR

TRANSLATES HAND-DRAWN WAVEFORMS INTO
EQUIVALENT D-C ELECTRICAL OUTPUT SIGNALS



Draw desired single-valued time functions as simple or complex waveforms on STATA-TRAK program chart.



Attach chart to program drum, and mount in STATA-TRAK Arbitrary Function Generator.



Drum rotates chart past program sensor; STATA-TRAK translates hand-drawn waveforms into equivalent electrical output signals.

This unique new concept in function generators (patent pending) is capable of generating infinite combinations of continuously repetitive waveforms ranging from the simplest ramp to the most complicated combination of curved-and-linear, variable amplitude and duration functions in the form of direct electrical output signals.

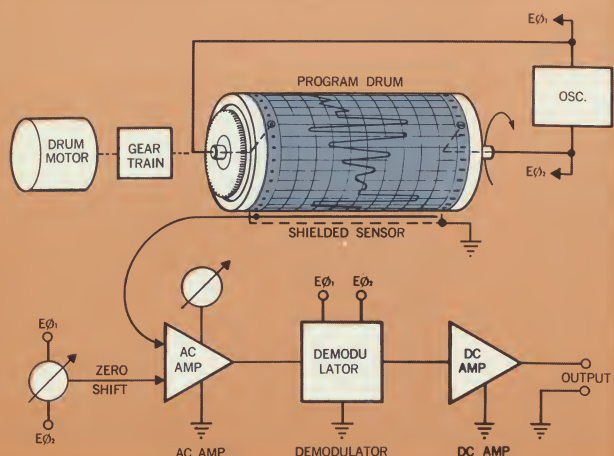


CONTROLS DIVISION
RESEARCH, INCORPORATED
MINNEAPOLIS 24, MINNESOTA

STATA-TRAK is an electronic instrument which directly translates hand-drawn arbitrary single-valued time functions into equivalent electrical output signals.

STATA-TRAK provides the means for generating arbitrary electrical functions ranging from single linear ramps to complex continuously repetitive waveforms combining variable amplitudes, durations, slopes and pulse sequences. **STATA-TRAK'S** easy-to-use electrostatic program-sensing system eliminates the complicated electronics and piece-by-piece synthesis of fundamental and harmonic frequencies usually required to construct complex waveforms by biased-diode methods.

FUNCTIONAL DIAGRAM



HOW IT WORKS

A waveform is drawn on **STATA-TRAK** metallized program-chart paper with an electrical etching stylus. The etching process removes a fine line of metal from the chart, dividing the surface into two electrically-isolated conductive segments. The chart is subsequently mounted on a program drum, inserted into **STATA-TRAK**, and rotated at a preselected speed past the stationary probe, as shown in the diagram at the left.

The sensing electrode is a fine wire depressed into a milled slot in the program sensor surface adjacent to the drum. The sensor spans the active width of the chart and is spaced a fixed distance from the drum surface. The two metallized chart segments are energized with oppositely-phased high frequency voltages from the a-c oscillator. These voltages are capacitively summed by the sensing electrode in linear proportion to the division of the chart established by the waveform line. The total capacity between electrode and chart surface is held constant by the fixed sensor-drum spacing. If the waveform line divides the chart surface into two equal segments, the capacity between each segment and the electrode is equal and the voltages cancel. Electrical zero can, however, be shifted in either direction using the zero shift potentiometer.

The electrode is connected by a shielded wire to the input of a solid state a-c amplifier. A span control on this amplifier allows an adjustment between the plotted amplitude of the waveform and the subsequent output of the **STATA-TRAK**. A phase-sensitive demodulator converts the a-c amplifier voltage to an equivalent d-c voltage accurately representing the hand-drawn program waveform. A d-c amplifier provides ± 5 volts output with an impedance of 500 ohms.



IMPORTANT FEATURES

- | | |
|--|--|
| 1 Metallized Program Chart | 8 Time-Base Motor |
| 2 Waveform Program Line | 9 Solid-State Circuitry |
| 3 Non-Contacting Program Sensor | 10 Span Control |
| 4 Recessed Lock | 11 Zero Shift Control |
| 5 Mode Switch — Off, Remote, Hold, Run Positions | 12 Swing-Out Chassis — for easy Access |
| 6 Dust-Tight Cabinet | 13 Contact Pins |
| 7 Program Drum | 14 Micro-Switches |
| | 15 Spare Contact Pins |

STATA-TRAK ADVANTAGES

DIRECT DATA CONVERSION — Plotted waveforms are converted directly to equivalent electrical signal.

RECTILINEAR PLOTTING — 11-inch plotting resolution on amplitude scale, 13½-inch on time scale.

REUSABLE PROGRAMS — Program sensor does not contact chart; no noise or chart wear.

ADJUSTABLE TIME BASE — Drum speed can be adjusted over wide limits by gear and/or synchronous-motor changes.

VARIABLE SPAN — Span potentiometer allows adjustment between plotted amplitude and equivalent electrical signal.

VARIABLE ZERO — Zero potentiometer allows shifting of electrical zero over full chart width.

NO OVERSHOOT — Precision solid-state circuitry and stationary sensor design prevent both overshoot and velocity errors. No servo system.

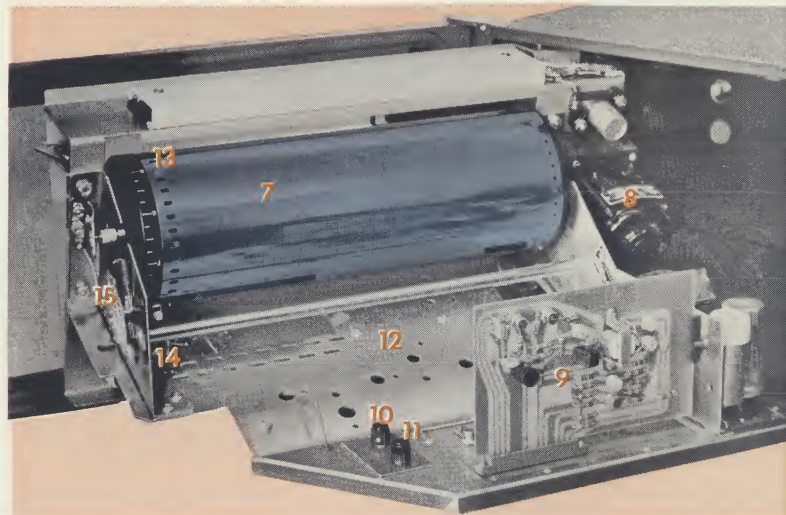
REPETITIVE WAVEFORMS — Plotted waveform repeats with each drum revolution.

SELF CONTAINED — All necessary circuitry contained within **STATA-TRAK** swing-out chassis. Connect to 115 VAC, 60 cycles.

HIGH RESPONSE — Electronic response flat to 1700 cps.

RUGGED INDUSTRIAL CONSTRUCTION — Heavy gauge steel enclosure with gasketed cast door for resistance against shock, dust and vibration.

REMOTE PROGRAM HOLD — Program drum can be stopped at any point in waveform cycle, holding existing voltage level.

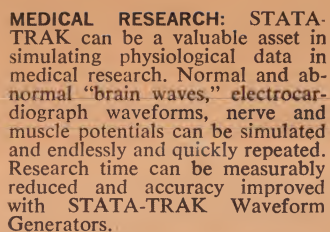


SERVO SYSTEM ANALYSIS: **STATA-TRAK** Waveform Generators make the task of investigating and analyzing servo-systems and components simpler, faster and more accurate. Any program of single-valued time functions can be drawn and faithfully reproduced as a d-c output signal. Need even more complexity? Use two **STATA-TRAKS**, one for X axis and one for Y, and sum the combined output.



MATERIALS AND STRUCTURES RESEARCH: Random, highly repeatable fatigue test programs are essential to critical evaluation of materials and structures. **STATA-TRAK** input through high-response servo-controllers provides arbitrary and cyclic programming of load or strain to automatically simulate stresses experienced by a material or component in actual or accelerated use.

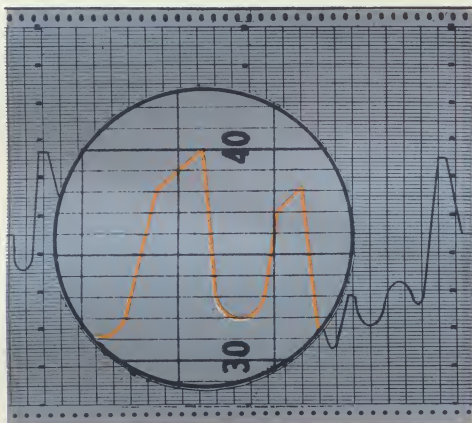




VIBRATION AND SHAKER-TABLE DRIVER: STATA-TRAK performs ideally as the waveform generator and driver for vibration and rate tables of all sizes and capacities. STATA-TRAK can also be utilized to produce compensating waveforms sometimes required to offset overshoot characteristics of vibration equipment which may be encountered in certain applications.

Programs are prepared quickly and easily by "drawing" desired waveforms on metallized STATA-TRAK chart paper with an electric Etching Stylus, used like a pencil. This paper is coated with a very thin but durable conductive metal film on which precisely divided coordinate scales are printed.

Drawing the electric stylus over the metallized surface (as one would draw with a sharp pencil on ordinary graph paper) produces a fine red line where the contrasting backing paper is exposed by evaporation of the metal film from the path of the stylus. The ease with which this narrow (.015-inch) line can be precisely plotted is a major factor in the accuracy of the STATA-TRAK programming system.



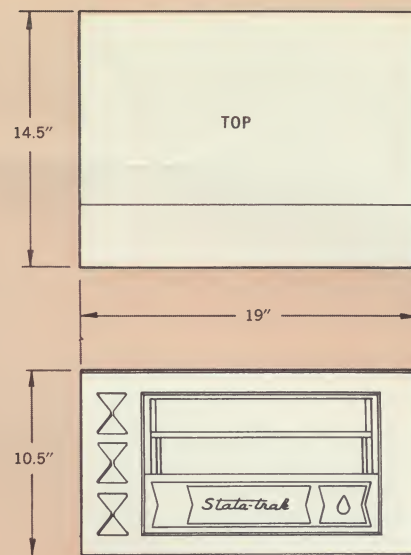
Model ES 5140 Etching Stylus is energized by a small d-c power supply that operates on 110-volt, 60-cycle current. Contact is made with the paper through the power supply base by merely resting the power supply on one corner of the chart. The circuit is completed by touching the tip of the stylus to the metallized paper, where a small arc evaporates the metal coating from the paper. Standard drafting triangles and curves may be used as guides.

In this illustration of a complete program chart, a full-size blow-up shows the actual width of program line commonly used.

GEAR TRAIN SS — SLOW SPEED								GEAR TRAIN HS — HI SPEED								CHANGE GEARS	
[2] DRUM MOTOR		[4] DRUM MOTOR		[10] DRUM MOTOR		[60] DRUM MOTOR		[10] DRUM MOTOR		[60] DRUM MOTOR		[300] DRUM MOTOR		NO. OF TEETH	GEAR LETTER		
IN / HR.	HR. / REV.	IN / HR.	HR. / REV.	IN / HR.	HR. / REV.	IN / MIN.	MIN. / REV.	IN / MIN.	MIN. / REV.	IN / SEC.	SEC. / REV.	IN / SEC.	SEC. / REV.				
$\frac{3}{4}$	18	$1\frac{1}{2}$	9	$3\frac{3}{4}$	$3\frac{8}{10}$	$\frac{3}{8}$	36	$2\frac{1}{2}$	$5\frac{4}{10}$	$\frac{1}{4}$	54	$1\frac{1}{4}$	$10\frac{8}{10}$	16 64	C H		
1	$13\frac{1}{2}$	2	$6\frac{3}{4}$	5	$2\frac{7}{10}$	$\frac{1}{2}$	27	$3\frac{1}{3}$	$4\frac{1}{20}$	$\frac{1}{3}$	$40\frac{1}{2}$	$1\frac{2}{3}$	$8\frac{1}{10}$	24 72	J N		
$1\frac{1}{2}$	9	3	$4\frac{1}{2}$	$7\frac{1}{2}$	$1\frac{8}{10}$	$\frac{3}{4}$	18	5	$2\frac{7}{10}$	$\frac{1}{2}$	27	$2\frac{1}{2}$	$5\frac{4}{10}$	32 64	K M		
2	$6\frac{3}{4}$	4	$3\frac{3}{8}$	10	$1\frac{7}{20}$	1	$13\frac{1}{2}$	$6\frac{2}{3}$	$2\frac{1}{40}$	$\frac{2}{3}$	$20\frac{1}{4}$	$3\frac{1}{3}$	$4\frac{1}{20}$	32 48	E F		
3	$4\frac{1}{2}$	6	$2\frac{1}{4}$	15	$\frac{9}{10}$	$1\frac{1}{2}$	9	10	$1\frac{7}{20}$	1	$13\frac{1}{2}$	5	$2\frac{7}{10}$	48 48	L L		
$4\frac{1}{2}$	3	9	$1\frac{1}{2}$	$22\frac{1}{2}$	$\frac{6}{10}$	$2\frac{1}{4}$	6	15	$\frac{9}{10}$	$1\frac{1}{2}$	9	$7\frac{1}{2}$	$1\frac{8}{10}$	48 32	F E		
5	$2\frac{7}{10}$	10	$1\frac{7}{20}$	25	$\frac{27}{50}$	$2\frac{1}{2}$	$5\frac{4}{10}$	$16\frac{2}{3}$	$\frac{81}{100}$	$1\frac{2}{3}$	$8\frac{1}{10}$	$8\frac{1}{3}$	$1\frac{62}{100}$	50 30	G D		
6	$2\frac{1}{4}$	12	$1\frac{1}{8}$	30	$\frac{9}{20}$	3	$4\frac{1}{2}$	20	$\frac{27}{40}$	2	$6\frac{3}{4}$	10	$1\frac{7}{20}$	64 32	M K		
9	$1\frac{1}{2}$	18	$\frac{3}{4}$	45	$\frac{3}{10}$	$4\frac{1}{2}$	3	30	$\frac{9}{20}$	3	$4\frac{1}{2}$	15	$\frac{9}{10}$	72 24	N J		
10	$1\frac{7}{20}$	20	$\frac{27}{40}$	50	$\frac{27}{100}$	5	$2\frac{7}{10}$	$33\frac{1}{3}$	$\frac{81}{200}$	$3\frac{1}{3}$	$4\frac{1}{20}$	$16\frac{2}{3}$	$\frac{81}{100}$	50 15	B A		
12	$1\frac{1}{8}$	24	$\frac{9}{16}$	60	$\frac{9}{40}$	6	$2\frac{1}{4}$	40	$\frac{27}{80}$	4	$3\frac{3}{8}$	20	$\frac{27}{40}$	64 16	H C		
SPEED RANGE	I	SPEED RANGE	II	SPEED RANGE	III	SPEED RANGE	IV	SPEED RANGE	V	SPEED RANGE	VI	SPEED RANGE	VII				

ADDITIONAL TYPICAL APPLICATIONS

- Replacement for Waveform Synthesizers
- Simulator for Waveform Analysis and distortion studies
- Function Generator for Analog Computers
- Testing and checkout of telemetry system components
- Simulator applications requiring high-response analog input
- Arbitrary Programmer for quality control check-out of components



PERFORMANCE DATA

WAVEFORM TYPES	Infinite. Hand-drawn single-valued time functions — complex linear, curved and standard waveform combinations.
PROGRAMMABLE FREQUENCY RANGE	D-C to 160 cps with no overshoot or velocity lag (determined by drum rotation speed and intervals at which functions are plotted on 13½" STATA-TRAK program chart paper. Recommend plotting max. of 8 cycles per inch for optimum performance).
SYSTEM FREQUENCY RESPONSE PHASE LAG, OVERSHOOT	D-C to 1.7KC
PROGRAM SENSOR	None (direct electrostatic pickup — no servo system).
CONTROLS: ZERO SHIFT	Electrostatic, non-contacting. No program chart wear.
SPAN	Enables operator to shift zero level of output signal in either negative or positive direction.
HOLD	Enables operator to adjust the range of output signals to correspond to the span of the charted program.
PROGRAM CHART PREPARATION	Permits operator to stop program at any point while retaining systems at operational status quo. Switching to RUN position continues operational cycle from HOLD point. Waveforms easily programmed with Electric Etcher on STATA-TRAK chart paper. Usable programming area 11" W x 13½" L (circumference of drum). Available in 50-ft. rolls (MCR 10-R5000 paper). See Data sheet 502.14

SPECIFICATIONS

RESOLUTION	Infinite.
LINEARITY	± 2%
ACCURACY	± 2% full scale.
OUTPUT	±5 volts. Other ranges available. Control wiring is connected to barrier strip inside cabinet.
TIME BASE	Adjustable from ¾" per hour to 20" per second by changing motor and/or gears. See table "Chart Speed Data." Higher speeds optional.
AMPLIFIER	Solid-state circuitry on plug-in board.
MAX. OUTPUT IMPEDANCE	500 ohms nominal
LINE VOLTAGE	115V a-c, 60 cycles, .3 amperes
DRUM ROTATION	Continuous.
DRUM DRIVE	OPTIONAL: 1) Preset Counter to shut down STATA - TRAK automatically after predetermined number of repetitive cycles. 2) Microswitch Trip Tabs or Reed Switches to limit drum rotation to 360°
WEIGHT	Synchronous motor through precision gear train.
DIMENSIONS	50 LBS. 10½" high, 19" wide, 15" deep.

ORDERING
EXAMPLE

FGE 5124 -SS



GEAR TRAIN

-60



DRUM MOTOR

BA



GEAR SET

R-I CONTROLS designs and manufactures complete temperature, power and process-control equipment and systems. For those who are building or implementing their own facilities, the following related modular units are offered:

PROGRAMMERS — DATA-TRAK Curve-Followers, PREKORDER Programmer-Recorder-Controllers. (Request Bulletin 502)

COMBINED TEMPERATURE-POWER CONTROLLERS — High-performance THERMAC Solid State Controllers. (Request Bulletin 501)

POWER REGULATORS — Ignitron, Thyatron and Solid-State Power Regulators. (Request Bulletin 503.2)



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Generate Arbitrary Waveforms

Draw any arbitrary waveform—this generator transforms it into a repetitive electrical signal.

Most waveform generators are limited to producing either sinusoid, square-wave or ramp functions. Should any combination of sinusoid, ramp or square wave be necessary or, for that matter, if any arbitrary waveform is desired, the necessity of an alternate solution to the problem becomes evident.

One solution consists of hand-drawing the desired waveform on metallized program-chart paper with an electrical etching stylus. A high-current density at the tip of the stylus evaporates metal from the chart at the point of contact. Thus, a continuous program line drawn from one end of the chart to the other separates program-chart paper into separate electrically conductive areas. Between each metallic section and a common sensing electrode, there exists a minute capacitance. As the size of each area is varied (determined by location of the line), its capacitance changes. Program paper is wrapped about a rotating drum placed in proximity to sensor, which is held stationary. Capacitance from the two metallized segments form the variable arms of a capacitive voltage divider. Voltage at the sensing electrode is thus an exact replica of the original program drawn on the paper.

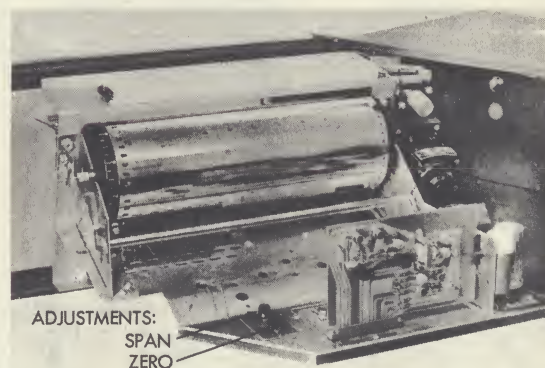
For the voltage to be usable, it must be amplified and demodulated before being delivered eventually as an output. Demodulator circuit is phase-sensitive. The flexible characteristics of the function gener-

ator, such as variable zero, variable amplitude, are handled by voltage dividers at amplifier inputs. In addition, any selected point on the waveform can be investigated by stopping the program drum without loss in the existing voltage level at that point.

The device, called the STATA-TRAK, was developed by the engineering group under the direction of James Anderson, vice president, Research, Inc., Controls Div., Minneapolis, Minn. ■

M. K. Bhatia, Midwest Editor

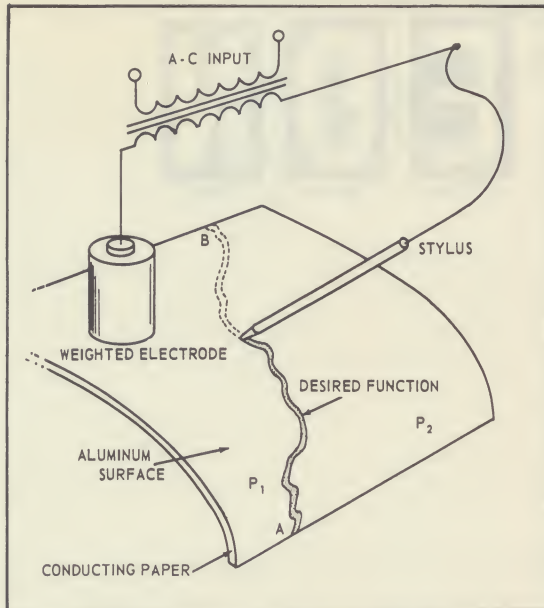
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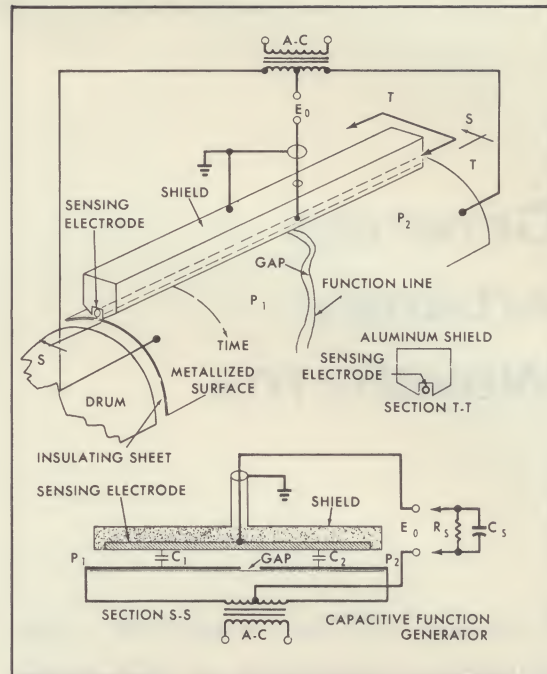
Easy access is necessary for drum removal and adjustments. Conducting paper should lie flat against drum, with ends of paper butted against each other.

(Continued)

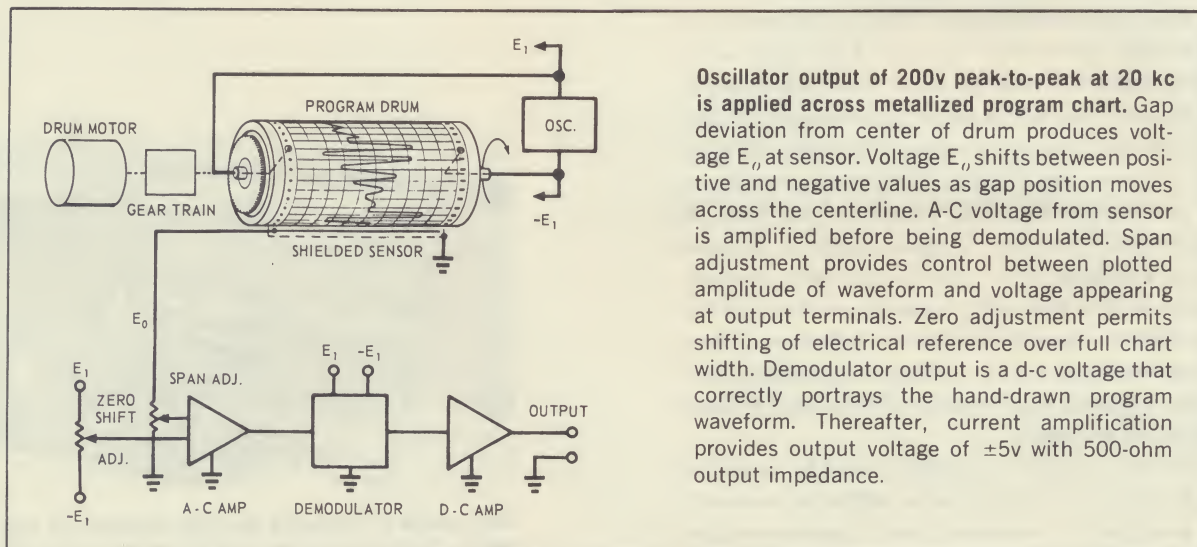
Arbitrary Waveforms (Cont'd)



To draw a desired function, paper is first placed on a flat surface. A weighted electrode is placed on a metallic surface. Electrode is connected to one end of a low-voltage a-c input, the other lead going directly to stylus. Circuit is completed through aluminum coating on paper when contacted by stylus. Current density at tip of stylus is sufficient to evaporate aluminum at point of contact, exposing a red dye underneath metallic surface. Desired waveform function is drawn by moving tip over entire length of aluminum sheet from A to B. An end-to-end function line is a must since it is essential that metallic surface be separated in two electrically isolated planes. P1 and P2.



Location and size of sensing electrode are essential to proper functioning of capacitive bridge. Sensor consists of wire embedded in milled slot in aluminum bar and insulated from bar by varnish. Bar serves as a shield and spans active width of conducting paper. Gap between wire and paper is 25 mils. Capacitance between sensor and planes P1 and P2 are C1 and C2, respectively. As drum rotates, location of gap under sensor shifts, thereby varying sizes of conducting planes P1, P2. This results in changing values of C1, C2, which affect output voltage E_o .



Oscillator output of 200v peak-to-peak at 20 kc is applied across metallized program chart. Gap deviation from center of drum produces voltage E_o at sensor. Voltage E_o shifts between positive and negative values as gap position moves across the centerline. A-C voltage from sensor is amplified before being demodulated. Span adjustment provides control between plotted amplitude of waveform and voltage appearing at output terminals. Zero adjustment permits shifting of electrical reference over full chart width. Demodulator output is a d-c voltage that correctly portrays the hand-drawn program waveform. Thereafter, current amplification provides output voltage of $\pm 5v$ with 500-ohm output impedance.



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August 9, 1966

Mr. T. Nelson
Systems Consultant
Box 1546
Poughkeepsie, New York 12603

Dear Sir:

We appreciate your expressing further interest in R-I Controls products.

We are enclosing current information for you concerning each additional product in which you indicated an interest.

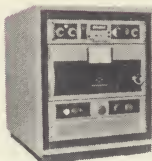
A "business card" indicating the name of our technical sales representative in your area is enclosed. Please feel free to call upon him if you would like further data, pricing, or application information.

Most sincerely,

RESEARCH, INCORPORATED

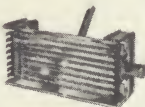
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THERMAC—High response Solid State—Temperature Control combined with proportional Ignitron Power Regulation. Power capacity from 50 amps. to 800 amps. 240, 400 or 600 volts. Ask for bulletin 501.

RADIANT HEATING—Complete line of Infrared Heating Reflector Modules, Specimen Furnaces, Custom Test Chambers and type T-3 Tungsten-filament Quartz Lamp Supports. Ask for bulletin 504.



DATA-TRAK—Curve-following Programmer. Converts stylus-drawn curve on metalized chart paper to proportional potentiometer output signal. Ask for bulletin 502.

In addition to the products shown above, our services include modular components and complete closed-loop systems for set-point and programmed laboratory and process control of temperature, pressure, radiant and resistance heating, and servo-hydraulic loads. Please contact our representative for full-line information. Additional current products: PRE KORDER Programmer-Controller-Recorder • HOT-BOX Universal Thermocouple Reference Junction • Displacement Transducers • LABAC Solid-State Proportional Power Controller • Heat Exchangers.

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A business card is attached for your convenience in filing. Please contact our representative if you need further information or prices.

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